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DESIGNATED/ELECTED OFFICE (DO/EO/US)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

CONCERNING A FILING UNDER 35 U.S.C. 371

09/856147

INTERNATIONAL APPLICATION NO.

PCT/DK99/00665

INTERNATIONAL FILING DATE

29 November 1999

PRIORITY DATE CLAIMED

30 November 1998

TITLE OF INVENTION

A METHOD OF PRODUCING A SUPERCONDUCTING TAPE

APPLICANT(S) FOR DO/EO/US

HAN Zhenghe

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Notice for Consideration of Documents Cited in International Search Report/Notice of Priority/PCT/IB/304
PCT/IB/308

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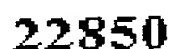
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- SEND ALL CORRESPONDENCE TO:**



SIGNATURE

C. Irvin McClelland

NAME _____

21,124

REGISTRATION NUMBER

DATE _____

09/856147

Rec'd PCT/PTO 30 MAY 2001

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Title: A method of producing a superconducting tape

Technical field

This invention relates to a method of producing a High Tc superconducting tape or a High Tc superconducting wire in a metallic sheath.

5 Background art

A high Tc superconducting wire/tape is usually a composite consisting of a superconducting core and a metallic sheath. Many properties of the wire/tape depend on the metallic sheath materials. Additional layers over the metallic sheath can, however, modify the properties of the wire/tape. For instance

- 10 (1) requires a superconducting device such as a motor, a transformer cable or a magnet additional insulating materials between the wires or between the adjacent turns of the winding in order to prevent short circuiting. According to EP 0 786 783 insulating layers have been applied between the superconducting layers formed by bare Bi-2223 tapes. High Tc wires having insulating surface layers could simplify
15 the process of making superconducting devices and the volume of the devices could be reduced.

- (2) the mechanical strength of a high Tc superconducting wire/tape depends on the sheath material. An Ag alloy sheathed tape is for instance much stronger than a tape sheathed with pure Ag. However, it is difficult to distinguish the Ag alloy from the
20 pure Ag just by looking. The additional surface layer can be coloured or marked which enable to distinguish between different kinds of wires/tapes. It is common that a tape is annealed in a pan-cake or solenoid form. Asymmetry pre-stress could be built up during the annealing and therefore two sides of a high Tc tape could have

different mechanical properties. It is therefore very important to be able to distinguish between the two different sides during a winding process, for instance by using different colours to distinguish between the two sides of the tape, one colour for the tensile stressed side and another colour for the compressed stressed side. As a result
5 a degrading of the wire/tape could be omitted.

(3) the Ag or Ag alloy sheath is not complete gas tight or liquid tight. Long time exposure in air or long time in contact with with liquid nitrogen could cause a degrading of the high Tc wire/tape. An additional layer could protect the tape from moisture, water, liquid nitrogen or other chemicals which could degrade the super-
10 conducting tape.

(4) the additional layer could change the surface friction of the wire/tape. A low friction is for instance needed for winding a superconducting cable.

Such additional layers could be applied by known techniques.

According to US patent specification No. 4 927 985 an insulating layer is applied
15 inside a conductor and the surface of the conductor is metallic. By this construction the insulating layer should be put in the conductor before the mechanical deformation and heat treatment. The materials suitable for the insulating layer are therefore restricted and organic materials cannot be used.

EP0044144 (US4407062) concerns a low Tc superconductor. Low Tc superconduct-
20 tors are totally different from high Tc superconducting materials. The low Tc materials mentioned in EP 0044144 is intermetallic. High Tc superconductors are ceramic. The method for producing the low Tc superconductor is therefore different from the method for producing high Tc superconductors.

Moreover the coating according to EP0044144 is applied before the final heat treatment.

The coating materials are therefore for high temperature use and could for instance be composite of silicate, chalk and China clay.

- 5 Without high temperature firing the coating is not stable. It can be simply removed by wiping in hot water and wiping conf. page 10 lines 7-10.

From EP 04449316 A1 it is known to cover a superconducting wire with an organic coat so as to stabilize the superconducting wire against bending.

Brief description of the invention

- 10 The object of the invention is to illustrate how the restriction as to the materials could be omitted and according to the invention the additional layer/layers is/are applied after the final annealing. As a result the above-mentioned problems have been solved.

According to the invention the coating is performed after the final heat treatment and the coating materials are typically polymers.

- 15 By using a coloured or a marked surface layer one will be able to distinguish between the different wires or different portions of the same wire, for instance to mark one of the sides of the wire/tape.

- According to the invention the surface layer could have a low friction and for instance being composed of teflon. Low friction is for instance needed for winding of
20 a superconducting cable.

3a

Brief description of the drawings

In the following the invention will be disclosed in closer detail with reference to the attached figures.

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Fig 1 is a sectional view of a high Tc superconducting wire.

Fig 2 is a sectional view of a multi-filamentary tape.

Fig 3 is a sectional view of a bunch of multi-filamentary tapes.

Fig 4 illustrates a continuous coating line for the surface layer over the high Tc
5 superconducting tape.

Best mode for carrying out the invention

Example 1.

In fig. 1 an insulating layer (3) of a thickness of 0,015 mm is applied to a high Tc Bi-2212 wire having a ceramic Bi-2212 core (1) and a metallic sheath (2). The material of the insulating surface layer is PVB and is applied to the wire by a standard
10 dip-coating method at a speed of 5 meters/min using alcohol as a solvent for PVB (5 weight% of PVB). Thereafter the solvent is evaporated and the PVB is cured at a temperature of 250° C in one minute. The surface layer is electrical insulating and can also protect the wire from water and liquid nitrogen.

15 Example 2.

In Fig. 2 a surface layer of a multilayer structure is applied to a multifilamentary Bi-2223 tape. This tape contains a number of Bi-2223 filaments (1) in a metallic matrix (2). The surface layer contains an insulating layer (3) and an outer low friction layer (4). The insulating layer (3) is applied by using a multifunctional acrylic resin which
20 is cured by means of UV light of 2J/cm² by using e. g. a standard Nextrom OFC coating line. A suitable material for the low friction layer is teflon which is applied by a standard dry-powder-coating technique using e.g. a Haugaard powder coating gun. The multilayer surface is insulating and has a low surface friction. A low surface friction can reduce stress in the tape during the winding as well as during the

operation of a superconducting apparatus.

Example 3.

In Fig. 3 the surface layer is applied to a bunch of multifilamentary Bi-2223 tapes. Each of the Bi-2223 tapes is coated with an insulating layer (3) using the method according to example 2. The bunch of the tapes is therefore coated with a low friction (4) layer as described in example 2.

Example 4.

Fig. 4 illustrates a continuous coating line for the surface layer over the high T_c superconducting tape. The finally annealed superconducting tape with metallic surface is sent to a coating apparatus 7 where the surface layer is applied over the tape surface. The coating method can be any traditional coating technique, e.g. dip-coating, spraying, extrusion, painting or dry-powder-coating. The tape with the applied layer is thereafter sent to another apparatus for curing 8. The curing method can be heating or UV curing. After the curing step the coated superconducting tape is ready for use. Of course, more steps can be involved when multilayer structure or colouring is needed.

Claims

1. A method of producing a high Tc superconducting tape or a high Tc superconducting wire with a metal sheath, said method comprising a number of annealing steps, characterised in that an additional surface layer for modifying the properties
5 of the wire/tape is applied after the final annealing.
2. A method according to claim 1, characterised by a surface layer of electrical insulating material.
3. A method according to claim 1, characterised by using a coloured or a marked surface layer so as to be able to distinguish between different wires or different
10 portions of the same wire, for instance to mark one of the sides of the wire/tape.
4. A method according to claim 1, characterised by a surface layer having a low friction.
5. A method according to claim 4, characterised in that the surface layer with a low friction is composed of teflon.
- 15 6. A method according to claim 1, characterised in that the coating material is polyurethane, polyesterimide, epoxy, teflon or another insulating material.
7. A method according to claim 6, characterised in that the surface layers contain ceramic powder, graphit, carbon, fiber or metallic particles/fibres.
8. A method according to claim 1, characterised by applying the insulating
20 layer by painting, coating, DIP-coating, spaying or dry powder coating.

9. A method according to claim 1, characterised in that the coating is thermal curable, UV curable or solvent based.
10. A method according to claim 1, characterised in that the surface layer is of a single or a multilayer structure.
11. A method according to claim 1, characterised in that the surface layer is over a single wire/tape or over a bunch of wires/tapes.

1990-1991		1991-1992		1992-1993		1993-1994		1994-1995		1995-1996		1996-1997		1997-1998		1998-1999		1999-2000		2000-2001		2001-2002		2002-2003		2003-2004		2004-2005		2005-2006		2006-2007		2007-2008		2008-2009		2009-2010		2010-2011		2011-2012		2012-2013		2013-2014		2014-2015		2015-2016		2016-2017		2017-2018		2018-2019		2019-2020		2020-2021		2021-2022		2022-2023		2023-2024		2024-2025		2025-2026		2026-2027		2027-2028		2028-2029		2029-2030		2030-2031		2031-2032		2032-2033		2033-2034		2034-2035		2035-2036		2036-2037		2037-2038		2038-2039		2039-2040		2040-2041		2041-2042		2042-2043		2043-2044		2044-2045		2045-2046		2046-2047		2047-2048		2048-2049		2049-2050		2050-2051		2051-2052		2052-2053		2053-2054		2054-2055		2055-2056		2056-2057		2057-2058		2058-2059		2059-2060		2060-2061		2061-2062		2062-2063		2063-2064		2064-2065		2065-2066		2066-2067		2067-2068		2068-2069		2069-2070		2070-2071		2071-2072		2072-2073		2073-2074		2074-2075		2075-2076		2076-2077		2077-2078		2078-2079		2079-2080		2080-2081		2081-2082		2082-2083		2083-2084		2084-2085		2085-2086		2086-2087		2087-2088		2088-2089		2089-2090		2090-2091		2091-2092		2092-2093		2093-2094		2094-2095		2095-2096		2096-2097		2097-2098		2098-2099		2099-2100		2100-2101		2101-2102		2102-2103		2103-2104		2104-2105		2105-2106		2106-2107		2107-2108		2108-2109		2109-2110		2110-2111		2111-2112		2112-2113		2113-2114		2114-2115		2115-2116		2116-2117		2117-2118		2118-2119		2119-2120		2120-2121		2121-2122		2122-2123		2123-2124		2124-2125		2125-2126		2126-2127		2127-2128		2128-2129		2129-2130		2130-2131		2131-2132		2132-2133		2133-2134		2134-2135		2135-2136		2136-2137		2137-2138		2138-2139		2139-2140		2140-2141		2141-2142		2142-2143		2143-2144		2144-2145		2145-2146		2146-2147		2147-2148		2148-2149		2149-2150		2150-2151		2151-2152		2152-2153		2153-2154		2154-2155		2155-2156		2156-2157		2157-2158		2158-2159		2159-2160		2160-2161		2161-2162		2162-2163		2163-2164		2164-2165		2165-2166		2166-2167		2167-2168		2168-2169		2169-2170		2170-2171		2171-2172		2172-2173		2173-2174		2174-2175		2175-2176		2176-2177		2177-2178		2178-2179		2179-2180		2180-2181		2181-2182		2182-2183		2183-2184		2184-2185		2185-2186		2186-2187		2187-2188		2188-2189		2189-2190		2190-2191		2191-2192		2192-2193		2193-2194		2194-2195		2195-2196		2196-2197		2197-2198		2198-2199		2199-2200		2200-2201		2201-2202		2202-2203		2203-2204		2204-2205		2205-2206		2206-2207		2207-2208		2208-2209		2209-2210		2210-2211		2211-2212		2212-2213		2213-2214		2214-2215		2215-2216		2216-2217	
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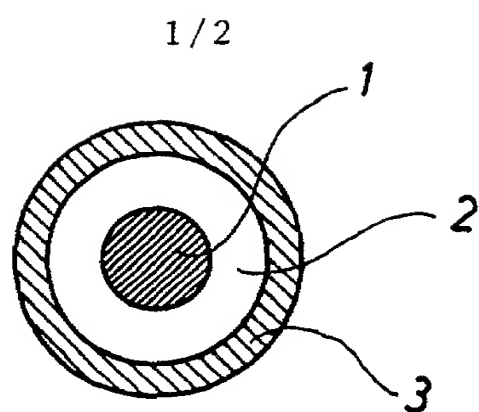


Fig. 1

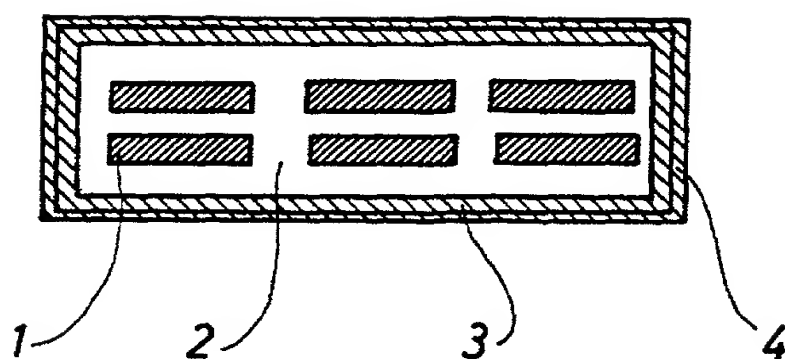


Fig. 2

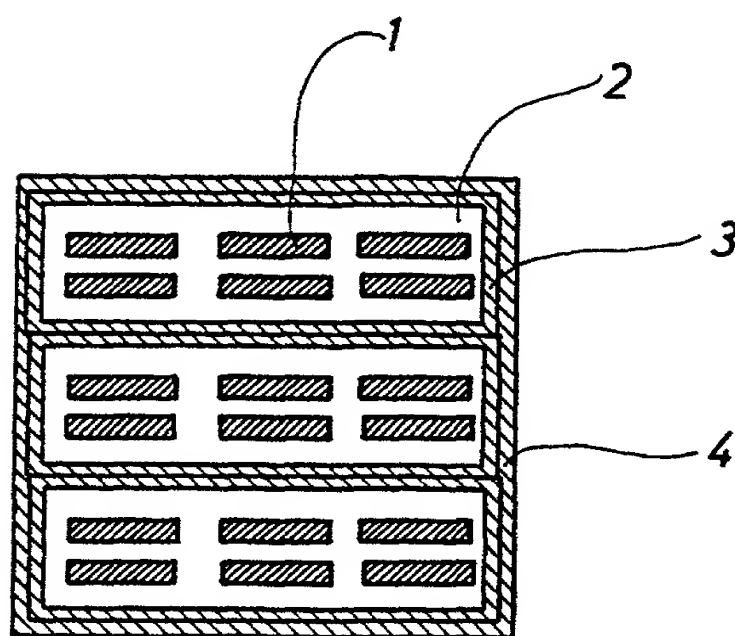


Fig. 3

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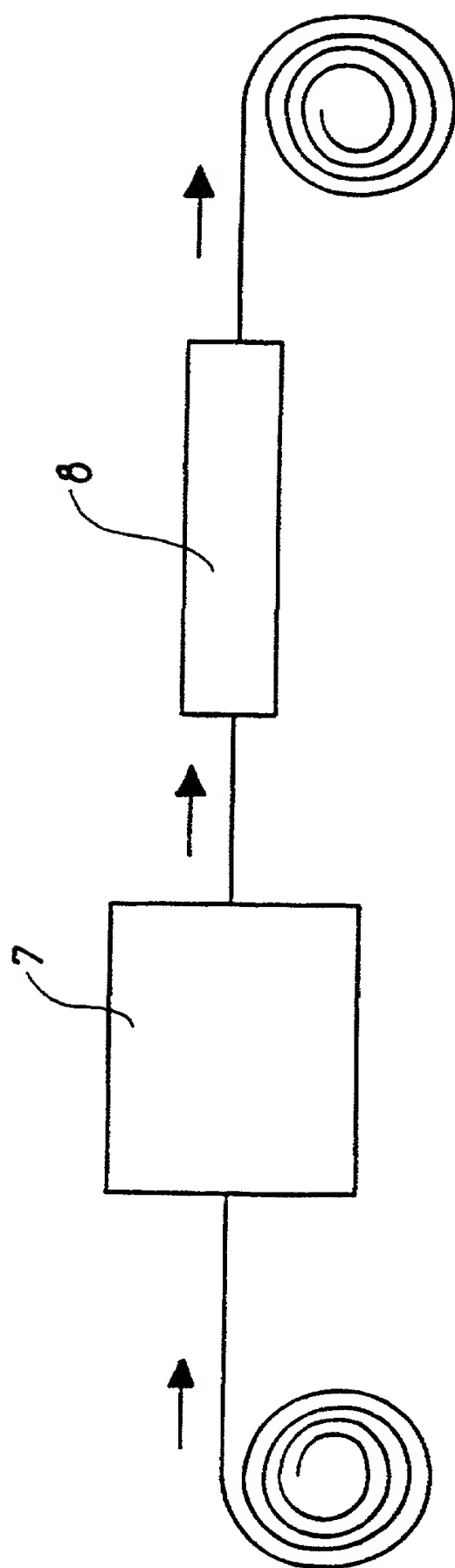


Fig. 4

Declaration, Power Of Attorney and Petition

Page 1 of 2

WE (I) the undersigned inventor(s), hereby declare(s) that:

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled

A METHOD OF PRODUCING A SUPERCONDUCTING TAPE

the specification of which

☐ is attached hereto.

☐ was filed on _____ as

Application Serial No. _____

and amended on _____.

☒ was filed as PCT international application

Number PCT/DK99/00665

on 29 November 1999,

and was amended under PCT Article 19

on 5 May 2000 (if applicable).

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application(s)

Application No.	Country	Day/Month/Year	Priority Claimed
PA 1998 01577	DENMARK	30 November 1998	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<u>Alan Z...</u>			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No

We (I) hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application Number)

(Filing Date)

(Application Number)

(Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or under § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

Application Serial No.

Filing Date

Status (pending, patented,
abandoned)

PCT/DK99/00665

29 November 1999

And we (I) hereby appoint the following registered practitioner(s):



022850

as our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to



022850

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Zhenghe HAN

NAME OF FIRST SOLE INVENTOR

Residence: Gammelgårdsvej 28a, DK-2730

Herlev, DENMARK **DKX**

Citizen of: China

Mailing Address: same as above

Man Z Le
Signature of Inventor

8 June 2001

Date